Human Emotional State and its Relevance for Military VR Training

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Abstract

Combat environments by their nature can produce a dramatic range of emotional responses in military personnel. When immersed in the emotional "fog of war", the potential exists for optimal human decision-making and performance of goal-directed activities to be seriously compromised. This may be especially true when combat training is conducted under conditions that lack emotional engagement by the soldier. Real world military training often naturally includes stress induction that aims to promote a similarity of internal emotional stimulus cues with what is expected to be present on the battlefield. This approach to facilitating optimal training effectiveness is supported by a long history of learning theory research. Current Virtual Reality military training approaches are noteworthy in their emphasis on creating hi-fidelity graphic and audio realism with the aim to foster better transfer of training. However, less emphasis is typically placed on the creation of emotionally evocative virtual training scenarios that can induce emotional stress in a manner similar to what is typically experienced under real world training conditions. As well, emotional issues in the post-combat aftermath need to be addressed, as can be seen in the devastating emotional difficulties that occur in some military personnel following combat. This is evidenced by the number of recent medical reports that suggest the incidence of "Vietnam-levels" of combat-related Post Traumatic Stress Disorder symptomatology in returning military personnel from the Iraq conflict. In view of these issues, the USC Institute for Creative Technologies (ICT) has initiated a research program to study emotional issues that are relevant to VR military applications. This paper will present the rationale and status of two ongoing VR research programs at the ICT that address sharply contrasting ends of the emotional spectrum relevant to the military: 1. The Sensory Environments Evaluation (SEE) Project is examining basic factors that underlie emotion as it occurs within VR training environments and how this could impact transfer of training, and 2. The Full Spectrum Warrior (FSW) Post Traumatic Stress Disorder Project which is currently in the process of converting the existing FSW combat tactical simulation training scenario (and *X-Box* game) into a VR treatment system for the conduct of graduated exposure therapy in Iraq war military personnel with Post Traumatic Stress Disorder.

1   Introduction

It is a commonly held belief in the field of Virtual Reality (VR) simulation training that increasing the sensory fidelity and interactional realism of a virtual environment (VE) will inevitably enhance transfer of training from the simulation to the real world. In pursuit of this goal, military VR developers often go to considerable effort and expense to create and deliver high quality graphical, audio and haptic sensory stimuli, in addition to creating methods of interaction that are natural or at least highly learnable. While these design challenges need to be addressed for optimal VR system development, there is often a single-mindedness that occurs in this effort that occludes consideration of another key factor in the user experience of military VR simulation training: *human emotional state.*

Anxiety is a common emotional state in military operating environments. Real world military training often naturally includes stress induction that aims to promote similarity of internal emotional stimulus cues with what is expected to be present on the battlefield. This approach to facilitating optimal training effectiveness is supported by a long history of learning theory research. For example, as far back as 1903, E.L. Thorndike formulated the "identical elements" theory that postulated better transfer of training to occur with increased similarity between training tasks and actual criterion targets (Thorndike, 1903). However, Osgood (1949) reported 46 years later that a

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"Similarity Paradox" occurs when highly specific simulation training produces learning that needs to be unlearned as the criterion task or environment changes (commonly referred to as *Negative Transfer*). This would suggest that learning that was acquired under non-stress conditions might not transfer well when that learned performance is required under stress. This was documented much later in the learning theory literature by Overton (1964) who published a seminal paper on "state dependent learning" that extended the identical elements and similarity paradox hypotheses to underlying internal physiological and emotional states. Simply put, Overton and many others that followed, demonstrated that learning which takes place under specific physiological conditions, whether caused by drug administration or emotional experiences, will have a higher probability of being recalled when the initial physiological state that learning initially occurred under is present. These findings suggest that if VR training is to effectively transfer to criterion environments that may engender a range of innate stress reactions, then that training should be conducted while the user is experiencing a similar range of emotional states. Since, military operations are constantly in a state of dynamic change, learning theory would dictate that optimal VR training should also include training under a wide range of emotional states in order to counteract the possibility of negative transfer and to promote successful performance in military environments that may inherently induce a dramatic range of emotional states.

Conversely, habituation to stress induction can also support adaptive task performance in stressful situations. This can anecdotally be seen when repeated exposure to stressful military training leads to a gradual decline in anxiety responses as the trainee learns to "manage" stress. In this case, it would be expected that "cool-headed" optimal performance would transfer to real world stress laden military environments. Ample evidence for such a habituation process can be seen in the fledgling VR/mental health field whereby phobic patients are able to effectively face what they initially feared following systematic VR exposure to such similar feared stimulus environments (Glantz, Rizzo & Graap, 2003).

In view of these issues, the USC Institute for Creative Technologies (ICT) has initiated a research program to study emotional issues that are relevant to VR military applications. This paper will outline and review research from two ongoing projects at the ICT that address sharply contrasting ends of the emotional spectrum relevant to the military. These are: 1. **Sensory Environments Evaluation (SEE) Project** – The SEE research program is initially examining basic factors that may underlie emotion and training, and 2. **The Full Spectrum Warrior Post Traumatic Stress Disorder (PTSD) Therapeutic Virtual Environment** -- The primary aim of this project is to use the already existing Full Spectrum Warrior (FSW) combat tactical simulation training scenario as the basis for creating a clinical VR application for the habituation/exposure treatment of PTSD in returning Iraq War military service personnel.

2 The Sensory Environments Evaluation (SEE) Project

2.1 Introduction

The SEE Project is primarily concerned with the emotional state of the human participant within virtual training environments. Specific interest is directed towards three principal research foci: 1. The role of the sensory inputs that define the VE (sight, sound, smell, and haptics) in inducing emotional states; 2. How evoked emotions valence the perception and realistic feeling of the VE; and finally, 3. How emotions can be used to increase the effectiveness of VEs as training systems. Including emotional components is a relatively recent but increasingly important aspect of virtual environment design. It is expected that such attention to the user's emotional state will overcome issues related to extant military virtual training environments, such as a lack of serious mental investment in the training experience, as well as insufficient pedagogical retention. These issues may be due in part to the lack of stress hormones (i.e., cortisol) being released during a VE experience, which we hypothesize to be the result of ineffective emotional stimulus design within the VE, and insufficient priming of participants' expectations before the VE is even entered. The SEE project is therefore conducting ongoing experiments in multi-sensory VE design for emotional impact in training environments, and investigating the effect of both sensory corroboration and priming on behaviour, arousal, and retention within these VEs.

2.2 Emotional Connections

The creation of a virtual environment from the perspective of its emotional impact is a relatively new take on the typical VR design process. SEE's approach is to filter the goals of the training experience through this emotional

lens. A reconnaissance scout, for example, must constantly be alert, even through periods where nothing much happens. The territory he or she is tasked with traversing can be fraught with dangers, some man-made and real, others psychological or tied to the fear of the unknown. As often as possible, corroborative details are used to augment the emotional triggers within the virtual environment (Morie, et. al. 2003).

The design process methodology includes not only individual sensory triggers, but also effective combinations of sensory stimuli to create a situation that "feels real", even absent full photographic or physics realism. With the focus on how the user will experience the orchestrated sensory stimuli, a gestalt of cues can work in concert to effectively present a world that compels the user to forego their natural awareness of being in a technologically mediated world. This aims to provide a strong sense of presence – a key factor of total involvement in the training scenario as described by Witmer & Singer (1998), Slater (1999), Usoh. (2000), IJsselsteijn (2003), Waterworth (2003), and others.

2.3   Evaluation Procedure

The first study by this group is in progress and is investigating the effects of both Instructional Priming and Olfactory sensory stimuli on presence, memory and physiological arousal in a two by two factorial design with a non-military sample. The Instructional Priming condition focuses on what the participant is told about the purpose of the VR experience in order to impact pre-training expectancies and set up a valenced connection to the experience. In one condition, users view a videotape of a "game-developer" inviting them to try out a new simulation "game". The other condition has subjects view a mission briefing instructional video (delivered by a "serious" actor in a military uniform) that informs them that this is an actual mission training scenario and that their performance will be evaluated (see Figures 1-2). As the basic task required for each condition is the same (navigation behind enemy lines to plant a GPS device near a suspected enemy camp) this manipulation is intended to compare induced expectancies about the seriousness of the mission via their impact on behavior, arousal and retention in a VR scenario. The olfactory condition requires subjects to wear a custom "scent-collar" that is programmed to deliver four scents that correspond to specific points in the VE (swamp, metallic, fresh outdoors and diesel fuel). One group receives scents; the other group wears the collar but does not receive the scents.   Users are also outfitted with a physiological monitoring systems recording EKG and skin conductance to ascertain arousal states throughout their sessions. Simple observational questions are administered to each subject at the end of the session to determine if they recall the emotional triggers with greater frequency than other elements in the scenario. Finally, the same questions are asked again via a phone interview one week later to test memory durability for the remembered elements.

Figure 1: Priming is delivered by themed characters   **Figure 2: Culvert Exit of the DarkCon VE**

Thus far sixty-four subjects have been fielded and the data is being mined to determine significant differences between the four study groupings. One consequence of a VE scenario that allows a free will experience for the user is that the multiplicity of data collected requires further processing to make adequate correspondences between subjects, who will not all have identical experiences. Such multivariate data from the current study has obviated the need for more robust tools to process, correlate and query data that includes:

- User data, both pre and post experience obtained via questionnaires (user characteristics, game playing habits, immersive tendencies and simulator sickness status)
- Biometric data collected from the physiological monitors (heart rate and SCR)

- Behavioral data from the user's actions within the VE (collected by means of trackers that register and record movement in x, y, and z Cartesian space as well as pitch, roll and yaw along these same axes).

The SEE team has developed a data processing and visualization tool called *Phloem* that can handle the arousal and behavioral data recorded from each subject. Phloem provides a post-experience playback mechanism permitting the examination of triggers with associated responses along simultaneous video and biometric axes with their associated displays on screen. In addition, Phloem allows specific queries to be made to this data to ascertain, for example, if a user actually encountered a particular trigger object or event or not. Absence of such an encounter would not be counted as an error in the immediate and delayed recall segments of the study.

Data analysis of the SEE's initial experiment is ongoing, but preliminary results indicate a relationship between priming groups and categorical memory durability of the virtual experience. These memory durability scores are derived by comparing participants' recall immediately following the experience to their recall after a one-week delay, and categorizing their responses into animal, character, object, vehicle, and weapon memories. The group primed to believe the experience is a "game" showed significant memory durability in the vehicle category ($p < .01$ and mean = 0.003) showing very little decline in vehicles remembered over the course of the week between interviews. By contrast, the group primed to believe the experience a "serious training exercise" showed significant memory durability in the weapons category (with $p < .01$ and mean = -4.586), in fact remembering them more completely a week later than at the close of the experience. We conjecture that the serious-primed group may be mentally rehearsing their performance over the course of that week, leading to such increased recall. This suggests a domain-specific attentiveness on the part of participants in the "serious" group, but as neither of the groups showed significant durability across more than one category, it is necessary to determine if each group's behavior and physiological response at the presentation of stimuli from each category corroborate these retention findings.

The current research is serving as an initial user-centered design trial to examine presence ratings, physiological arousal and memory for the spatial layout and objects in the VE in order to evolve the environment and methodology for later use by military trainees under more emotionally laden conditions where the consequence of failing could result in the delivery of aversive stimuli (i.e., shock, threat of shock, loss of financial incentives, etc.). Additional studies on the effects of both emotional and aversive stimuli will be augmented by the inclusion of more sophisticated non-invasive biometric sensors, such as functional near-infrared spectroscopy (fNIRS) as described in Hoshi (2001) which highlights activated brain regions that can be more closely correlated with attention and emotional states than the current basic arousal measures.

3 The Full Spectrum Warrior Post Traumatic Stress Disorder (PTSD) Therapeutic Virtual Environment

3.1 Introduction

In 1997, researchers at Georgia Tech released the first version of the Virtual Vietnam VR scenario for use as a graduated exposure therapy treatment for Post Traumatic Stress Disorder with Vietnam veterans. This occurred over 20 years following the end of the Vietnam War. During that interval, in spite of valiant efforts to develop and apply traditional psychotherapeutic approaches to PTSD, the progression of the disorder in some veterans severely impaired their functional abilities and quality of life, as well as that of their family members and friends. The tragic nature of this disorder also had significant ramifications for the U.S. Veteran's Administration healthcare delivery system often leading to designations of lifelong service connected disability status. Just recently, the first systematic study of mental health problems due to the Iraq conflict revealed that *"…The percentage of study subjects whose responses met the screening criteria for major depression, generalized anxiety, or PTSD was significantly higher after duty in Iraq (15.6 to 17.1 percent) than after duty in Afghanistan (11.2 percent) or before deployment to Iraq (9.3 percent)"* (Hoge et al., 2004). With this history in mind, the USC Institute for Creative Technologies (ICT) has initiated a project that is creating an immersive virtual environment system for the treatment of Iraq War veterans diagnosed with combat-related PTSD. The proposed treatment environment is based on a creative approach to recycling virtual assets that were initially built for a combat tactical simulation scenario entitled *Full Spectrum Command*, which later inspired the creation of the commercially available X-Box game, *Full Spectrum Warrior*. This paper will briefly present the vision, rationale, technical specifications, clinical interface design and development status of the Full Spectrum PTSD treatment system that is currently in progress at the USC ICT.

3.2 Post Traumatic Stress Disorder

According to the DSM-IV (1994), PTSD is caused by traumatic events that are outside the range of usual human experiences such as military combat, violent personal assault, being kidnapped or taken hostage, terrorist attack, torture, incarceration as a prisoner of war, natural or man-made disasters, automobile accidents, or being diagnosed with a life-threatening illness. The disorder also appears to be more severe and longer lasting when the event is caused by human means and design (bombings, shootings, combat, etc.). Such incidents would be distressing to almost anyone, and is usually experienced with intense fear, terror, and helplessness. Typically, the initiating event involves actual or threatened death or serious injury, or other threat to one's physical integrity; or witnessing an event that involves death, injury, or a threat to the physical integrity of another person. Symptoms of PTSD are often intensified when the person is exposed to stimulus cues that resemble or symbolize the original trauma in a *non-therapeutic* setting. Such *uncontrolled* cue exposure may lead the person to react with a survival mentality and mode of response that could put the patient and others at considerable risk. The essential feature of PTSD is the development of characteristic symptoms that may include:

● Intrusive thoughts and flashbacks	● Hyper-alertness
● Anger	● Suicidal feelings and thoughts
● Isolation	● Alienation
● Emotional numbing and constriction	● Negative self-image
● Anxiety	● Memory impairment
● Depression	● Problems with intimate relationships
● Substance abuse	● Emotional distance from family and others
● Survivor guilt	● Denial of social problems

Prior to the availability of VR therapy applications, the existing standard of care for PTSD was *imaginal* exposure therapy. Such treatment typically involves the graded and repeated imaginal reliving of the traumatic event within the therapeutic setting. This approach is believed to provide a low-threat context where the patient can begin to therapeutically process the emotions that are relevant to the traumatic event as well as de-condition the learning cycle of the disorder via a habituation/extinction process. While the efficacy of imaginal exposure has been established in multiple studies with diverse trauma populations (Rothbaum, Meadows & Resick, 2000; Rothbaum & Schwartz, 2002), many patients are unwilling or unable to effectively visualize the traumatic event. In fact, avoidance of reminders of the trauma is inherent in PTSD, and is one of the defining symptoms of the disorder. It is often reported that, *"...some patients refuse to engage in the treatment, and others, though they express willingness, are unable to engage their emotions or senses."*(Difede & Hoffman, 2002). Research on this aspect of PTSD treatment suggests that the inability to emotionally engage (*in imagination*) is a predictor for negative treatment outcomes (Jaycox, Foa & Morral, 1998).

The use and value of Virtual Reality for the treatment of cognitive, emotional, psychological and physical disorders has been well specified (Glantz et al., 2003; Rizzo, Schultheis, Kerns & Mateer, 2004). The first use of VR for a Vietnam veteran with PTSD was reported in a case study of a 50-year-old, Caucasian male veteran meeting DSM-IV criteria for PTSD (Rothbaum et al., 1999). Results indicated post-treatment improvement on all measures of PTSD and maintenance of these gains at a 6-month follow-up. This case study was followed by an open clinical trial of VR for Vietnam veterans (Rothbaum et al., 2001). In this study, 16 male PTSD patients were exposed to two HMD-delivered virtual environments, a virtual clearing surrounded by jungle scenery and a virtual Huey helicopter, in which the therapist controlled various visual and auditory effects (e.g. rockets, explosions, day/night, yelling). After an average of 13 exposure therapy sessions over 5-7 weeks, there was a significant reduction in PTSD and related symptoms. Similar positive results have also recently been reported for VR applied to PTSD resulting from the attack on the World Trade Center (Difede & Hoffman, 2002). In this report, a case study was presented using VR to provide re-exposure to the trauma with a patient who had failed to improve with traditional exposure therapy. The authors reported significant reduction of PTSD symptoms by exposing the patient to explosions, sound effects, virtual people jumping from the burning buildings, towers collapsing, and dust clouds and attributed this success partly due to the increased realism of the VR images as compared to the mental images the patient could generate in imagination. Such early results suggest that VR may be a valuable technology to apply as a component within a comprehensive treatment approach for persons with combat-related PTSD.

3.2   Full Spectrum Warrior Background and Development History

The primary aim of the current project is to use the already existing ICT Full Spectrum Warrior graphic assets (go to: http://www.ict.usc.edu/disp.php?bd=proj_games_fsw for video demo) as the basis for creating a clinical VR application. The ICT games project has created two training tools for the U.S. Army to teach leadership and decision making skills. Full Spectrum Command (FSC) is a PC application that simulates the experience of commanding a light infantry company. FSC teaches resource management, adaptive thinking, and tactical decision-making. Full Spectrum Warrior, developed for the Xbox game console, puts the trainee in command of a nine-person squad. Trainees learn small unit tactics as they direct fire teams through a variety of immersive urban combat scenarios. These tools were developed through collaboration between ICT, entertainment software companies, the U.S. Army Training and Doctrine Command (TRADOC), and the Research, Development, and Engineering Command, Simulation Technology Center (RDECOM STC). Additionally, Subject Matter Experts from the Army's Infantry School contributed to the design of these training tools. The current VR PTSD application is designed to run on two Pentium 4 notebook computers each with 1 GB RAM, and a 128 MB DirectX 9 compatible graphics cards. The two computers are linked using a null Ethernet cable. One notebook runs the therapist's control application while the second notebook drives the user's head mounted display (HMD), orientation tracker and navigation controls. The application is built on ICT's FlatWorld Simulation Control Architecture (FSCA). The FSCA enables a network-centric system of client displays driven by a single controller application. The controller application broadcasts user triggered or scripted event data to the display client. The client's real-time 3D scenes are presented using Numerical Design Limited's (NDL) Gamebryo graphics engine.

3.3   Full Spectrum Warrior PTSD VR System Features

We have created a prototype virtual environment designed to resemble a middle-eastern city (see Figures 3-7). This VE was designed as a proof of concept demonstrator and as a tool for initial user testing to gather feedback from both Iraq War military personnel and clinical professionals in order to refine the city scenario and to seek guidance regarding the future expansion of the system to include other relevant scenario settings. The vision for the project includes, not only the design of a series of diverse scenario settings (e.g. outlying village and desert scenes), but as well, the creation of options for providing the user with different first person perspectives. These choice options when combined with real time clinician input via the "Wizard of Oz" clinical interface is envisioned to allow for the creation of a user experience that is specifically customized to the needs of the patient participating in treatment. The software is being designed such that clinical users can be teleported to specific scenario settings based on a determination as to which environment most closely matches the patient's needs, relevant to their individual combat related experiences. These settings include:

1. City Scenes – In this setting, we are creating two variations. The first city setting (similar to what we have in our prototype) will have the appearance of a desolate set of low populated streets comprising of old buildings, ramshackle apartments, a mosque, factories and junkyards (see Figures 3-4). The second city setting will have similar street characteristics and buildings, but will be more highly populated and have more traffic activity, marketplace scenes and monuments.
2. Checkpoint – This area of the City Scenario will be constructed to resemble a traffic checkpoint with a variety of moving vehicles arriving, stopping and then moving onward.
3. City Building Interiors – Some of the City Scenario buildings will have interiors modelled that will allow the user to navigate through them. These interiors will have the option of being vacant (see Figure 5) or have various levels of populated virtual characters inhabiting them.
4. Small Rural Village – This setting will consist of a more spread out rural area containing ramshackle structures, a village center and much decay in the form of garbage, junk and wrecked or battle-damaged vehicles. It will also contain more vegetation and have a view of a desert landscape in the distance that is visible as the user passes by gaps between structures near the periphery of the village.
5. Desert Base – This scenario will be designed to appear as a desert military base of operations consisting of tents, soldiers and an array of military hardware.
6. Desert Road – This will consist of both paved and dirt roadway which will connect the City scenario with the Village scenario. The view from the road will mainly consist of desert scenery and sand dunes (see Figure 6) with occasional areas of vegetation, ramshackle structures and battle wreckage.

Figure 3. City View

Figure 4. "Flocking" Patrol

Figure 5. Interior View

Figure 6. Desert Road View
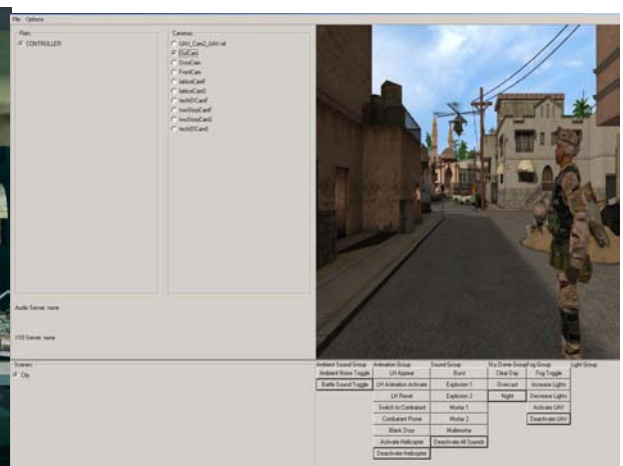

Figure 7. HUMVEE View

Figure 8. Clinical Interface

Once the scenario setting is selected, it will be possible to select from a variety of user perspective and navigation options. These are being designed in order to again provide flexibility in how the interaction in the scenario settings can be customized to suit the clinical user's needs. These options will include:

1. User walking alone on patrol from a first person perspective.
2. User walking with one soldier companion on patrol. The accompanying soldier will be animated with a "flocking" algorithm that will place them always within a 5-meter radius of the user and will adjust position based on collision detection with objects and structures to support a perception of realistic movement.
3. User walking with a patrol consisting of a number of companion soldiers using a similar "flocking" approach as in #2 above (see Figure 4).
4. User view from the perspective of being in a HUMVEE or other moving vehicle as it automatically travels through the various setting scenarios (Figure 7). The interior view can have options for other occupant passengers that will have ambient movement. The view will also be adjustable to support the perception of travel within a convoy or as a lone vehicle.
5. User view from the perspective of being in a helicopter hovering above the scenarios.

In each of these user perspective options, the user may or may not possess a weapon, and in some cases the weapon will be usable to return fire when it is determined by the clinician that this would be a relevant component for the therapeutic process. We have also created an initial version of a "Wizard of Oz" type clinical interface (Figure 8). This interface is a key element in the application, as it needs to provide a clinician with a usable tool for placing the user in VE locations that resemble the setting and context in which the traumatic events initially occurred. As important, the clinical interface must also allow the clinician to further customize the therapy experience to the patient's individual needs via the systematic real-time delivery and control of "trigger" stimuli in the environment. This is essential for fostering the anxiety modulation needed for therapeutic habituation. In our initial configuration, the clinician has a separate computer monitor that displays the clinical interface controls. While the results from planned user studies will ultimately guide the interface design process, one possible candidate setup is to provide four quadrants in which the clinician can monitor ongoing user status information, while simultaneously directing trigger stimulus delivery. The upper left quadrant will contain basic interface menu keys used for placement of the patient (and immediate removal if needed) in the appropriate scenario setting and user perspective. This quadrant will also contain menu keys for the control of time of day or night, atmospheric illumination, weather conditions and initial ambient sound characteristics. The lower left quadrant will provide space for real-time display of the patients' heart rate and GSR readings for monitoring of physiological status. The upper right quadrant will contain a window that displays the imagery that is present in the user's field of view in real-time. And the lower right quadrant contains the control panel for the real-time delivery of specific trigger stimuli that are actuated by the clinician to modulate appropriate levels of anxiety as required by the theory and methodology of exposure-based therapy.

The specification and creation of such trigger stimuli is an evolving process that has begun with our intuitive efforts to include options that have been reported to be relevant by returning soldiers and combat environment experts. For example, Hoge et al., (2004) present a useful listing of combat related events that were commonly experienced in their sample of returning Iraq War military personnel. These events provide a useful starting point for conceptualizing how relevant trigger stimuli could be presented in a VE, including: "*Being attacked or ambushed, Receiving incoming artillery, rocket, or mortar fire, Being shot at or receiving small-arms fire, Shooting or directing fire at the enemy, Being responsible for the death of an enemy combatant…*" (p. 18). From this and other sources, we have begun our initial effort to conceptualize what is both functionally relevant and pragmatically possible to include as trigger stimuli in our current clinical interface.

3.4   Conclusion

War is perhaps one of the most challenging situations that a human being can experience. The physical, emotional, cognitive and psychological demands of a combat environment place enormous stress on even the best-prepared military personnel. Training must reflect the intensity of the situation, and projects such as the Sensory Environments Evaluation are addressing this need. Until we are able to effectively do this, we will continue to deal with the after affects of unprepared soldiers dealing with such extreme and emotionally charged situations. One of the more foreboding findings in the recent Hoge et al., [1] report, was the observation that among Iraq War veterans, "*...those whose responses were positive for a mental disorder, only 23 to 40 percent sought mental health care. Those whose responses were positive for a mental disorder were twice as likely as those whose responses were*

negative to report concern about possible stigmatization and other barriers to seeking mental health care." (p. 13). While military training methodology has better prepared soldiers for combat in recent years, such hesitancy to seek treatment upon return from combat, especially by those who may need it most, suggests an area of military mental healthcare that is in need of attention. In this regard, perhaps a VR system for PTSD treatment could serve as a component within a reconceptualized approach to how treatment is accessed by veterans returning from combat. One option would be to integrate VR combat exposure as part of a comprehensive "assessment" program administered upon return from a tour of duty. Since past research is suggestive of differential patterns of physiological reactivity in soldiers with PTSD when exposed to combat-related stimuli (Keane et al., 1998; Laor et al., 1998), an initial procedure that integrates our VR PTSD application with physiological recording could be of value. If indicators of such physiological reactivity are present during an initial VR exposure, a referral for continued care could be negotiated and/or prescribed. Finally, one of the guiding principles in our development work concerns how VR can *extend* the skills of a well-trained clinician. This VR approach is not intended to be an automated treatment protocol that could be administered in a "self-help" format. The presentation of such emotionally evocative VR combat-related scenarios, while providing treatment options not possible until recently, will most likely produce therapeutic benefits when administered within the context of appropriate care via a thoughtful professional appreciation of the complexity and impact of this disorder.

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